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SID 62-700-

PRELIMINARY
APOLLO GROUND OPERATIONS
REQUIREMENTS SPECIFICATION
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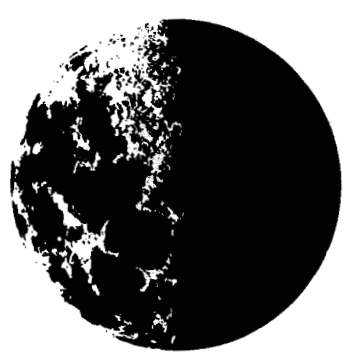

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SID 62-700-3

PRELIMINARY
APOLLO GROUND OPERATIONS
REQUIREMENTS SPECIFICATION
(U)

30 September 1962

NAS 9-150

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Approved by

J. W. Paup

Vice President and Apollo Program Manager

[redacted]

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

[redacted]

1. SCOPE

1.1 Specification Scope. - This specification generally defines the ground operations required: (1) to prepare the Apollo spacecraft for flight, (2) to monitor and evaluate Apollo crew and spacecraft performance parameters during the various missions, and (3) to retrieve the crew and command module after touchdown.

1.2 Ground Operations Objective. - The overall objective shall be to establish functional requirements and delineate provisions for ground services necessary to support spacecraft missions so that a high probability of mission success is assured.

1.3 Specification Organization. - The Apollo General Requirements are contained within three separate specifications as follows:

Preliminary Apollo Mission Requirements	SID 62-700-1
Preliminary Apollo Spacecraft Requirements	SID 62-700-2
Preliminary Apollo Ground Operations Requirements	SID 62-700-3

1.3.1 Specification Relationship. - The Apollo specifications relationship is shown in Figure 1.

2. APPLICABLE DOCUMENTS

2.1 Applicability. - The following documents of the issue in effect on the date of contract form a part of this specification to the extent specified herein.

SPECIFICATIONS

North American Aviation, Inc., Space and Information Systems Division

SID 62-700-1	Preliminary Apollo Mission Requirements Specification
SID 62-700-2	Preliminary Apollo Spacecraft Requirements Specification

2.2 Precedence. - The order of precedence in case of conflict shall be as follows:

(a) The contract

(b) This specification

(c) Other documents referenced herein

3. REQUIREMENTS

3.1 General Requirements. - This specification establishes the basic functional requirements for: (1) Ground Support Equipment (GSE), (2) the Ground Operational Support System (GOSS), (3) Checkout and Procedures, (4) Personnel, (5) Maintenance, (6) Logistics, (7) Facilities, and (8) Post-Flight Operations. Designation of specific contractor responsibilities for implementing these requirements will be established through negotiations between NASA and NAA-S&ID.

This specification does not define specific design, hardware, or performance parameters for any of the equipment. This information will be provided in other documentation.

The ground operations shall include the NAA (S&ID) - NASA acceptance checkout of the spacecraft at Downey; checkout verification, countdown, and launch of the space vehicle at AMR; support of the spacecraft during flight; and retrieval of the Command Module and crew after touchdown.

3.2 Ground Support Equipment Functions. - Ground Support Equipment (GSE) is required to support the Apollo spacecraft checkout, servicing, handling, and auxiliary functions in the operations areas at NAA-S&ID and at AMR. The spacecraft systems shall be checked out for flight readiness based on satisfactory operational response to simulated flight evaluation signals.

3.2.1 Ground Checkout Equipment. - Ground checkout equipment shall be capable of accurately determining the functional status of the spacecraft to the replaceable package level by providing simulated activation control and checking responses on a go, no-go, or quantitative basis.

Automatic checkout equipment at S&ID and at AMR shall be capable of determining the functional status of: (1) individual systems, (2) combined systems, and (3) integrated systems in accordance with a predetermined checkout sequence. Provisions for a flight readiness readout shall be incorporated in the automatic checkout equipment so that the operational status of each spacecraft may be quickly determined.

Manual ground checkout equipment, which may be used in conjunction with the automatic checkout equipment, shall be capable of qualitatively determining the functional status of: (1) individual, (2) combined, and (3) integrated spacecraft operational systems.

3.2.2 Ground Service Equipment. - Ground service equipment shall be capable of providing fluid transfer (propellants, coolants, and compressed gases), pressurization, electrical power, communications, air conditioning, leak detection, tank dehumidification, and emergency equipment operation. The automatic servicing equipment shall be capable of operating with automatic checkout equipment programmed in a predetermined operational sequence. The manual service equipment shall be capable of operating independently or with the manual checkout equipment.

3.2.3 Ground Handling Equipment. - Ground handling equipment shall be provided to move and position spacecraft modules and module hardware and partially or completely assembled spacecraft whenever necessary. This equipment shall include dollies, cranes, and the launch-transporter crawler.

3.2.4 Auxiliary Ground Equipment. - Auxiliary equipment shall be provided for functional simulation of complete modules and substitution of spacecraft destructive devices for the purpose of operational checkout verification. Additional auxiliary equipment shall include an extensive intercommunications network consisting of a closed television monitoring circuit at AMR, and radio and telephone communications facilities at NAA-S&ID and at AMR.

3.2.4.1 Substitution Equipment. - Substitution equipment shall be provided to check out the functional interfaces between the spacecraft modules as required in various areas at NAA-S&ID and at AMR. This equipment shall verify the functional compatibility of the spacecraft modules before the actual mating operations.

3.2.4.2 Destructive Devices Substitution Equipment. - Substitution equipment for destructive devices shall be used to check out the operational capability of the Explosive Bridge Wire (EBW) system and the firing relays and cable systems for the various functional explosive systems in the spacecraft. This substitution equipment is necessary when the pyrotechnics are not installed in the space vehicle during checkout verification.

3.2.4.3 Intercommunications Checkout Network. - This network shall support the checkout operations. A closed circuit television network shall permit observation of checkout tests in various areas. A central control observation area shall permit overall assessment of the checkout tests being conducted. Multiplex transmission shall be provided from television cameras and monitors in remote or hazardous areas to the central observation area or other specified areas.

An intercommunications system shall be provided at NAA-S&ID and at AMR. A central AMR control area shall be linked with the major operational facilities, the Operations and Checkout Building, the Vertical Assembly Building, the Launch Control Center, and certain remote test sites. Voice communication shall be provided for the necessary coordination of activities. A conference voice system shall be provided for direct contact between the Launch Control Center and the crew in the spacecraft. Other conference networks shall be provided as required.

Provision shall be made for direct dialing and communication using standard telephone facilities when necessary. A public address system shall be provided in specified areas and buildings for certain required uses.

3.2.4.4 Optical Alinement Equipment. - Optical alinement equipment shall be provided to properly aline the Launch Escape System motors.

3.3 Ground Operational Support System Functions. - The ground operational support system (GOSS) functions will provide monitoring and surveillance of the performance of the spacecraft and the crew during each mission. These functions consist primarily of: (1) communications, (2) tracking, (3) data processing facilities, and (4) command control. Operational control of the support system will be exercised by the Mission Control Center (MCC) located at Houston, Texas. Detail GOSS performance and interface requirements are defined in SID Specification 62-1005.

3.3.1 Communications Requirements. - Communication systems will be provided for the necessary transmission of information between the spacecraft and ground stations. The information will be transmitted from the point of origin to the point of use in a form which can be analyzed by data processing equipment to evaluate flight control or system performance parameters. Telemetry, teletype, voice, and television, with corresponding recording equipment, will be the communication systems utilized.

3.3.1.1 Spacecraft to Earth. - The function of the spacecraft to earth communication link will be to transmit: (1) measurements of spacecraft systems performance not readily available to the crew, (2) voices of the crew, and (3) television signals to GOSS stations. All GOSS stations will have receiving and recording equipment for telemetry and voice. Selected GOSS stations will receive and record television signals. The remote stations will retransmit selected portions of all the recorded data to the MCC for analysis as necessary.

3.3.1.2 Earth to Spacecraft. - A voice modulation radio communication link will be provided between all GOSS stations and the spacecraft crew. The radio communication system will provide two-way voice contact for

real time exchange of information between the crew and contacting GOSS station necessary for surveillance and control of the mission.

3.3.1.3 Intersystem Link of Remote Stations to MCC. - Communication links will be established between each remote station and the MCC capable of the following transmissions: (1) radio, (2) radar measurements in real time, (3) television (those remote stations in continental United States), (4) selected telemetry measurements from the spacecraft, (5) teletype, and (6) telephone.

3.3.2 Tracking Requirements. - An extensive tracking radar network will be a major part of the GOSS system for close surveillance of the spacecraft during flight when visible from the earth. The radar tracking will provide accurate orbital data for verification of initial flight control conditions. The radar network will provide subsequent space position, earth-moon range, and spacecraft velocity information when required by the MCC during various phases of the mission. The tracking data will be provided in real or near real time to maintain continuously updated trajectory data. The resulting ground based determinations of position and velocity will be used to confirm the performance of the spacecraft guidance and navigation system and to provide acquisition data to the down range GOSS stations.

3.3.2.1 Near Earth Tracking. - Radar tracking of the spacecraft will be performed by ground based and shipboard remote stations possessing the required radar accuracy and position. These sites will primarily possess a monopulse instrumentation radar having: (1) an unambiguous range assumed to be line-of-sight with a 5-degree horizontal mask, and (2) digital readout facilities for range, range rate, azimuth, and elevation information.

Acquisition aids will be utilized to aid the tracking radar to reduce its search of volume and to achieve faster lock-on to the spacecraft. These aids will include: (1) advance trajectory information relayed to the remote GOSS tracking sites by the MCC and (2) remote site angle tracking real time information obtained by the telemetry antennas.

3.3.2.2 Deep Space Tracking. - The Deep Space Instrumentation Facility (DSIF) sites in the GOSS network will be utilized for spacecraft tracking and communications to lunar distances. The DSIF sites will possess the following characteristics: (1) unambiguous lunar range assumed to be line-of-sight with a 5-degree horizontal mask and (2) digital readout facilities for range, range-rate, azimuth, and elevation information.

Adequate tracking of the spacecraft at the distances involved will be accomplished with the aid of spacecraft transponders. Equipment capability requirements will be maintained between the spacecraft and the ground equipment for the various tracking functions involved.

3.3.3 Data Processing Requirements. - The Computer Complex at the MCC will be the data processing center for the GOSS network. The Complex will: (1) receive data from various sources, including the remote stations throughout the world; (2) store and analyze data for possible contingency situations; (3) monitor the progress of the mission; (4) compare the predicted sequence of mission events with the data received from the spacecraft and crew; and (5) compute information or commands for transmission to the crew.

3.3.3.1 Computer Complex Support of Spacecraft. - The Computer Complex will support the spacecraft by computer memory storage of the programed flight information for each mission.

3.3.3.1.1 Ascent Phase. - The spacecraft and launch vehicle systems performance data will be monitored and processed by the Launch Control Center at AMR to determine subsequent mission flight decisions. The automatic computer at the LCC shall contain the capability for sensing emergency conditions and alerting the spacecraft crew and ground control personnel of launch pad or initial flight contingencies.

3.3.3.1.2 Flight Phase. - The Computer Complex will process telemetered data to determine and verify the satisfactory performance of the spacecraft systems and the physiological condition of the crew. Continuous computations will be made of the spacecraft position in space and of the guidance and navigation system performance.

The Computer Complex will process critical performance data to determine flight parameter changes to be implemented by the spacecraft crew or GOSS stations. Repeat computations and separate special computations will be made when requested by the spacecraft crew or considered advisable by the MCC.

The MCC will alert the spacecraft crew to any critical condition indicated by the ground control and of the corrective measures to be taken by the crew after verification of the condition aboard the spacecraft.

3.3.3.1.3 Recovery Phase. - The MCC through utilization of the world wide GOSS station inputs and processing by the Computer Complex will provide the spacecraft crew with information on space conditions for determining earth entry path perturbations, landing site determination, the landing site weather, and possible touchdown conditions.

The MCC Computer Complex will be utilized to implement the recovery phase operations. Effective deployment of the recovery forces will be accomplished by initial computer memory storage of the position of the

recovery forces. Subsequent direction will be based on continuous tracking of the spacecraft during the earth entry phase to calculate and determine the landing location of the spacecraft.

3.3.3.2 Computer Complex Support of GOSS Stations. - The MCC Computer Complex will be capable of: (1) assessing the inputs from the GOSS stations, (2) evaluating the data monitored by the GOSS network, and (3) directing support to the spacecraft. The Computer Complex will compute the designation data for the GOSS network trackers. The Complex will transmit: (1) spacecraft orbital parameters to the GOSS stations equipped with digital computers; (2) look angles in real time where high speed data links are available; (3) look angles in non-real time where communication facilities are limited to teletype equipment; (4) process detailed GOSS station telemetry information, and (5) special information from MCC or remote station computers to assess indicated marginal or critical spacecraft conditions. The data transmitted to the MCC Computer Complex for processing from the remote GOSS stations will be selected to limit the data processing required to monitor and support the spacecraft. Overall integrated determinations and assessments of the progress of the mission will be made by the Computer Complex based on the inputs from all GOSS stations.

3.4 Checkout Concept and Procedures. - The checkout concept shall be composed of the requirements for checkout levels, launch rates, total checkout time, and crew-spacecraft checkout provisions. The checkout procedures shall cover requirements for all checkout areas both at NAA-S&ID and at AMR. The spacecraft checkout operations at NAA-S&ID shall include a functionally integrated checkout of the Guidance and Navigation System in the Command Module and of the crew within the Command Module to determine operational capability prior to shipment to AMR.

3.4.1 Checkout Level. - Checkout levels shall be commensurate with the capability of the checkout confirmation equipment and the objective of the performance verification check at each station.

3.4.1.1 Systems Checkout Level. - During the checkout of a system in the Command Module or Service Module, prior to mating, the checkout equipment shall be capable of confirming performance of most of the operational systems to the replaceable package level and of some of the systems to the component level.

3.4.1.2 Combined Systems Checkout Level. - During the checkout of combined systems in the spacecraft following the mating of the Command and Service Modules, the checkout equipment shall be capable of

confirming performance of the combined systems to the subsystem level and in some cases to the replaceable package level.

3.4.1.3 Integrated Systems Checkout Level. - During the checkout of integrated systems, which shall consist of the combined systems of the spacecraft and launch vehicle, the checkout equipment shall be capable of confirming performance capability of most of the combined systems to the system level and of some of the integrated systems to the subsystem level.

3.4.1.4 Launch Pad Checkout Level. - During the countdown, the checkout equipment shall be capable of confirming the performance of most of the integrated systems to the systems level and of some of the integrated systems to the subsystem level. Explosive or pyrotechnic systems shall generally be checked out to the component level during countdown.

3.4.1.5 Launch Rate Requirement. - The Apollo facilities at AMR shall be capable of processing spacecraft and launch vehicle systems to permit a projected launch rate of one space vehicle every two months.

3.4.1.6 Checkout Time Requirement. - The projected final assembly and checkout time shall be 80 ± 20 work days. Each work day shall consist of two eight-hour shifts for six days each week.

3.4.1.7 Crew-Spacecraft Checkout. - The crew and alternates shall participate in some phases of checkout of the Command Module. The crew shall actuate controls, observe displays, and evaluate system or systems performance under checkout conditions. Crew participation shall be consistent with safety provisions and training requirements.

3.4.2 Checkout Procedures. - Procedures shall be developed to cover the spacecraft functional requirements for all checkout areas at NAA-S&ID and at the Atlantic Missile Range. The procedures shall be sufficiently comprehensive to assure a complete checkout of the spacecraft. Hardware elements, individual systems, combined systems, and integrated systems checkout shall be compatible with mission objectives. The spacecraft equipment shall be checked in accordance with a simulated mission operational sequence when practicable. Checkout procedures requirements shall be commensurate with the checkout level at the various checkout stations.

3.5 Personnel Requirements. - The Apollo program will be manned by personnel qualified to implement and accomplish the objectives of the program. Determination of overall program personnel requirements will be coordinated with NASA and with all of the Apollo program Associate Contractors and Subcontractors.

3.5.1 Personnel Categories and Functions. - The primary personnel categories and functions considered in this specification will include the following:

(a) Administrative - Management coordination and direction to insure integrated accomplishment of necessary tasks.

(b) Scientists - Specialists in particular fields to provide and verify information needed in support of the spacecraft and definition of mission objectives and parameters.

(c) Engineers - Technical specialists primarily concerned with validation of the capabilities of the spacecraft and ground support equipment.

(d) Mathematicians - Specialists qualified to check and verify the mathematical considerations involved in the definition of each mission.

(e) Technicians - Support personnel to provide technical assistance particularly with the assembly and check out of the spacecraft and ground support equipment.

(f) Mechanics - Personnel particularly qualified in specific functions of hardware mechanical assembly.

(g) Flight Support Personnel - Personnel qualified in specific functions of prelaunch operations at AMR, MCC, and remote GOSS stations.

(h) Other Support Personnel - Personnel required to accomplish specific tasks at various levels of the program.

3.5.2 Safety Personnel. - Safety personnel will be provided to insure the safety of the spacecraft crew and ground operations personnel during operational checkout of the spacecraft and during the prelaunch countdown on the launch pad prior to liftoff. Ground personnel or the crew will activate the Launch Escape System in the event of a launch pad contingency. The Range Safety Officer will maintain necessary cognizance of initial launch conditions to insure the maximum safety conditions for the

spacecraft crew and personnel in the launch and down range areas. Medical personnel will monitor the physiological reactions of the crew.

3.6 Maintenance Concept. - Maintenance will be exercised to maintain the spacecraft at a high level of flight readiness. Such subsidiary equipment as ground support equipment, trainers, evaluators, and simulators will be maintained at a high level of operability during all phases of ground operations. Repair and replacement of failed hardware will be accomplished at levels commensurate with the capability established for each major operational area.

3.6.1 Levels of Repair and Retest. - Levels of repair and retest in each operational area will be determined by the functional support requirements for the spacecraft, by replacement spares, and by repair capability.

3.6.1.1 Maintenance Levels at NAA-S&ID. - Maintenance performed at NAA-S&ID shall reach to the lowest unit or detail part level. Malfunction isolation shall be to the replaceable package level during checkout. The faulty package shall then be removed and the malfunction isolated by bench maintenance equipment to the smallest serialized replaceable unit or part. Bench maintenance shall also include the recertification of spares at periodic intervals.

3.6.1.2 Maintenance Levels at AMR. - Maintenance performed in the Operations and Checkout Building and in the remote or hazardous area at AMR shall be to the replaceable package level. Bench maintenance shall be similar to that at NAA-S&ID except as limited by the availability of spares. Maintenance in the Vertical Assembly Building shall be to the subsystem or system level and maintenance at the launch pad shall be to the system level where possible.

3.6.1.3 NAA-S&ID Repair Functions. - Repair functions at NAA-S&ID shall be performed at three levels: (1) the acceptance and test level, (2) the bench maintenance level, and (3) the overhaul level. Repair at the acceptance and test level shall be accomplished by replacing the malfunctioning package. Repair at the bench maintenance level shall be done by replacing serialized units or parts which fail. Repair at the overhaul level shall be accomplished by complete reconditioning of the failed hardware.

3.6.1.4 AMR Repair Functions. - Repair at AMR shall be generally limited to the replacement of faulty packages. The replacement of faulty serialized units or parts in a failed package shall be limited to critical items.

3.6.2 General Maintenance. - General maintenance shall consist of: (1) receiving and periodic inspections of spacecraft hardware and subsidiary equipment, (2) servicing and handling of the spacecraft and supporting equipment, and (3) preventive maintenance on all equipment associated with ground operations functions.

3.7 Logistics Requirements. - Apollo logistics functions shall consist of the implementation of supply support requirements, training requirements, and transportation requirements.

3.7.1 Supply Support Requirements. - The primary functions of supply support shall be the establishment of provisioning policies, procedures, accountability, and control. Provisioning of spares and material consistent with checkout and maintenance requirements shall be maintained at NAA-S&ID and at the Atlantic Missile Range. Supply support personnel shall staff the NAA-S&ID and AMR support centers to assure that provisioning requirements are satisfied.

3.7.2 Transportation Requirements. - The Apollo spacecraft modules will be transported from NAA-S&ID to the Atlantic Missile Range by air. The spacecraft adapter will be transported by ship. The air transportation requirement is established for the spacecraft modules because transit time is a critical factor in the overall launch preparation schedule. In addition, the checkout schedules of the Command and Service Modules coincide to the extent that the two modules are required at the Atlantic Missile Range at the same time. Other modes of transportation may be used when permitted by the program schedule. Ship transportation for the spacecraft adapter is required because of the size of the adapter.

3.7.3 Training Requirements. - The training requirements shall consist of instructing: (1) the Apollo flight crews to operate the spacecraft by using simulated mission conditions, (2) the flight operations personnel to perform flight support functions by using simulated mission conditions, and (3) the preflight operations personnel to perform all operations necessary to prepare the spacecraft for flight by use of special training aids and devices.

3.7.3.1 Flight Crew Training. - Flight crew training shall be established to instruct the crew in the operation of all the spacecraft systems, systems management skills, and the coordination of crew-ground operations personnel functions.

3.7.3.2 Flight Operations Personnel Training. - Flight operations training shall be established to instruct ground personnel in spacecraft systems operation and monitor console interfaces. Training in communications, operations, and support functions between flight controllers and remote site personnel shall also be conducted.

3.7.3.3 Preflight Operations Personnel Training. - Preflight operations training shall be established to train personnel to perform functional checkouts, assembly and disassembly of the spacecraft, maintenance, and repair of spacecraft hardware to the component level.

3.8 Facilities Requirements. -

3.8.1 NAA-S&ID Facility Requirements. - The NAA-S&ID facilities shall consist of the manufacturing checkout facilities, and Engineering acceptance checkout facilities required to implement and support the Apollo program. The existing technical facilities of the other NAA regional Divisions shall be utilized when considered necessary. The basic functional capabilities of the S&ID facilities applicable to spacecraft operations within the scope of this specification are presented below.

3.8.1.1 Manufacturing Checkout Facilities. - The facilities shall provide a capability for checkout and verification of the performance capability of the spacecraft operational systems and ground support equipment. The checkout facilities shall provide the area and vertical space layout required to assemble the Apollo spacecraft. Necessary calibration facilities and equipment shall be provided to insure instrumentation accuracy.

3.8.1.2 Engineering Acceptance Checkout Facilities. - Facilities shall be provided for final spacecraft combined systems checkout.

The checkout equipment shall be housed in a control room located adjacent to checkout operational areas. Calibration facilities and equipment shall be provided to check the accuracy of all test equipment. Displays shall be located in the control room to provide a visual check of the data. Electronic laboratories and radiation shielded areas shall be provided for radiation control during the checkout operations.

The engineering acceptance checkout area shall be located adjacent to the final assembly area to minimize handling of the spacecraft modules.

A stockroom shall be provided to house all components and systems required for final assembly and checkout.

3.8.1.3 Data Ground Station. - An analog and digital computer data ground station shall be provided to process spacecraft systems performance checkout data. The PCM/PAM data acquisition and processing system shall be located adjacent to the final assembly and systems integration facility. A real time data display shall be provided.

3.8.2 AMR Facility Requirements. - The facilities at AMR will consist of several major operational buildings and the launch pad complex. The basic functional capabilities of these facilities are presented below. The facilities flow diagram and the ground operations diagram at AMR are shown in Figures 2 and 3. Utilization of other existing or additional new facilities will be made as necessary to accomplish program requirements.

3.8.2.1 Spacecraft Operations and Checkout Building. - This facility will provide the physical equipment and space layout for receiving inspection, subsystems performance checkout, and maintenance of the spacecraft Command Module, the Service Module, and the Adapter. The building will include a multi-story open bay area for assembly, interface systems integration, and combined systems checkout of the spacecraft modules. A vacuum chamber will also be provided for reduced pressure tests of the Command Module and Service Module.

3.8.2.2 Ordnance Facility. - An Ordnance Facility located in the Hazardous or Remote Area will provide the physical equipment and space layout for receiving inspection, modification, subsystems performance checkout, maintenance, and bonded storage of spacecraft solid propellant motors, explosive ordnance, pyrotechnic devices, and spare parts.

3.8.2.3 Parachute Building. - This facility will provide the physical equipment and space layout for receiving inspection, modification, parachute packing, and bonded storage of the Command Module parachute package.

3.8.2.4 Fluid System Test Facility. - This facility will provide the physical equipment and space layout for checkout and test of all fluid systems in the Command Module and Service Module.

3.8.2.5 Reaction Control System Building. - This facility will provide the physical equipment and space layout for static firing tests of the Reaction Control Systems of the Command Module and Service Module. The facility will include a high bay structure capable of containing an assembled spacecraft for the tests. Adjacent areas of the facility will include an instrumentation control room and appropriate support shops.

3.8.2.6 Static Firing Facility. - This facility will consist of rocket propulsion test stands, propellant supply system, hydraulic fluid and gas supply system, pressurization system, instrumentation control rooms, and an emergency safety system. Static firing tests of the Service Module propulsion system will be conducted at this facility. The facility will be capable of testing individual modules or an assembled spacecraft.

3.8.2.7 Weight and Balance Facility. - This facility will provide space and equipment for weight and balance checkout of the Command Module, Service Module, and Launch Escape System. Provisions will be made for physically and electrically mating the Command Module and the Launch Escape System and for subsequent weight, balance, and alinement of the mated modules.

3.8.2.8 Radar Boresight Facility. - This facility will contain the radar boresight target alinement equipment to properly aline the radar in the mated Command Module and Service Module.

3.8.2.9 AMR Apollo Launch Complex. - The Apollo Launch Complex 39 at AMR will consist of the necessary prelaunch operational facilities and related launch pad areas. The Launch Complex will be as shown in Figure 4 with the designated buildings and areas.

3.8.2.9.1 Vertical Assembly Building. - The Vertical Assembly Building will be a high bay structure equipped for the final assembly and checkout of the integrated spacecraft and launch vehicle. The facility will contain checkout equipment for verification of the integrated systems of the spacecraft and launch vehicle. The building will contain several bays for assembly and checkout of space vehicles simultaneously. The assembly areas will completely enclose the space vehicle during the greater part of the prelaunch checkout operations. A perspective drawing of the Vertical Assembly Building is shown in Figure 5.

3.8.2.9.2 Arming Tower. - The Arming Tower will be a single high bay structure located between the Vertical Assembly Building and the launch pad areas. The Arming Tower will be used for final installation of the flight ordnance equipment including the pyrotechnic devices, explosive units, and solid propellant motors for the Launch Escape System. The physical and electrical mating of the Launch Escape System and checkout of the Command Module - Launch Escape System intersystems will also be accomplished at the Arming Tower.

3.8.2.9.3 Launch Control Center. - The Launch Control Center will consist of automatic and manual checkout and launch control equipment. The Center will be linked by r-f communications and coaxial cable with the Launch Pad Areas and the Spacecraft Operations and Checkout Building. Final prelaunch checkout and actual launch control command of the space vehicle will be made from the Launch Control Center. The Launch Control Center will contain equipment to monitor and transmit space vehicle ascent position and initial trajectory information to the Mission Control Center at Houston, Texas.

3.8.2.9.4 Launch Pad Areas. - Each of the Launch Pad Areas will consist of large circular or rectangular concrete pads and structures equipped with a flame deflector, propellant supply facilities, electrical power, hydraulic fluid and pneumatic gas supplies, pressure systems, emergency fire and decontamination facilities, coaxial and r-f communication equipment, and personnel protective shelters. An umbilical tower will provide physical access to the space vehicle on the launch pad and will be used for entry of the crew into the Command Module. A perspective drawing of the launch pad area is shown in Figure 6.

3.8.2.9.5 Launch Complex Roadway. - A specially constructed reinforced roadway system will interconnect all of the major operational buildings and facilities of the Apollo AMR Launch Complex. The roadway will be structurally adequate to support the 2500 ton launch-transporter crawler when moving an assembled space vehicle and umbilical tower between the Vertical Assembly Building, the Arming Tower, and the Launch Pad Areas. The roadway surface will be smooth and level to minimize vibration and other adverse effects transmitted to the assembled space vehicle when being transported by the 2500-ton crawler.

3.8.3 Mission Control Center, Houston, Texas. - The complete facilities for monitoring, control, and direction of all Apollo mission objectives will be established at Houston, Texas. The facilities will include the necessary buildings and equipment to monitor the progress of the spacecraft immediately before and at all times after launch. The monitoring equipment will be capable of measuring all of the major performance parameters of systems aboard the spacecraft when direct line-of-sight communication is possible between the MCC and the spacecraft and will monitor such performance at all other times through a complex communications network established as an integral part of the GOSS networks.

3.8.4 GOSS Network Stations. - The GOSS system will consist of a world-wide network of communications, tracking, and control stations. Approximately twenty-five stations will be established at strategic locations throughout the world so that surveillance and monitoring of spacecraft flight progress, on-board systems, and crew status can be maintained. Existing GOSS stations will be incorporated into the Apollo network where feasible.

3.8.5 Other Facilities. - Other facilities will be established in accordance with the overall needs of the Apollo Program. These facilities are not defined in this specification as it is anticipated that they will evolve from subsequent requirements to be established as the program progresses.

3.9 Post Flight Operations. - The post flight ground operations will include all of the operations which take place after touchdown of the Command Module. These operations are: (1) establishing the touchdown location of the Command Module; (2) deployment of the ground recovery forces to locate and retrieve the spacecraft crew and the Command Module; (3) debriefing of the crew; (4) physical inspection of the Command Module.

3.9.1 Establishment of Touchdown Location. - Continuous tracking surveillance, monitoring, and voice communication, when possible, will be maintained between the spacecraft, the MCC, all GOSS stations in the vicinity of the entry window, and the ground recovery forces during the earth entry of the Command Module. The MCC Computer Complex will process telemetered entry tracking data along with memory-stored landing location data to determine the touchdown location and initiate deployment of the nearest ground recovery forces.

3.9.2 Recovery Operations. - The deployment of the recovery forces will be based on implementation of a general recovery operations plan. The plan will be predicated on the establishment of: (1) planned recovery areas, and (2) contingency recovery areas. Planned recovery areas will be those areas in which the probability of the touchdown of the Command Module is sufficiently high to require the pre-positioning of the recovery forces in the areas to assume recovery within a projected time. Contingency recovery areas will be those areas in which the probability of touchdown of the Command Module is considered sufficiently low to require only the utilization of standby recovery forces with specialized search and rescue capabilities. The MCC will deploy the recovery force nearest the determined or assumed touchdown location. When located, the crew and Command Module will be delivered to the nearest operational base.

3.9.3 Debriefing. - An initial medical examination will be made of the crew to determine each member's general physical condition. Specific tests will be made as considered advisable by the examining personnel. Debriefing personnel will interrogate the crew members regarding primary considerations of various aspects of the mission. The information disseminated by the crew members will be properly recorded. Subsequent debriefing operations will permit more detailed consideration of all aspects of the mission.

3.9.4 Physical Inspection of the Command Module. - Following delivery of the Command Module to the nearest Apollo operational base, a physical examination of the module will be made by qualified NASA and NAA-S&ID personnel.

3.9.5 Summary Activities. - The detailed examination of the Command Module and the analysis of the telemetered spacecraft performance data, together with the information provided by the crew, will permit an overall assessment to be made by NASA of the mission, the accomplishment of the objectives and the deficiencies indicated.

4. QUALITY ASSURANCE

Not applicable

5. PREPARATION FOR DELIVERY

Not applicable

6. NOTES

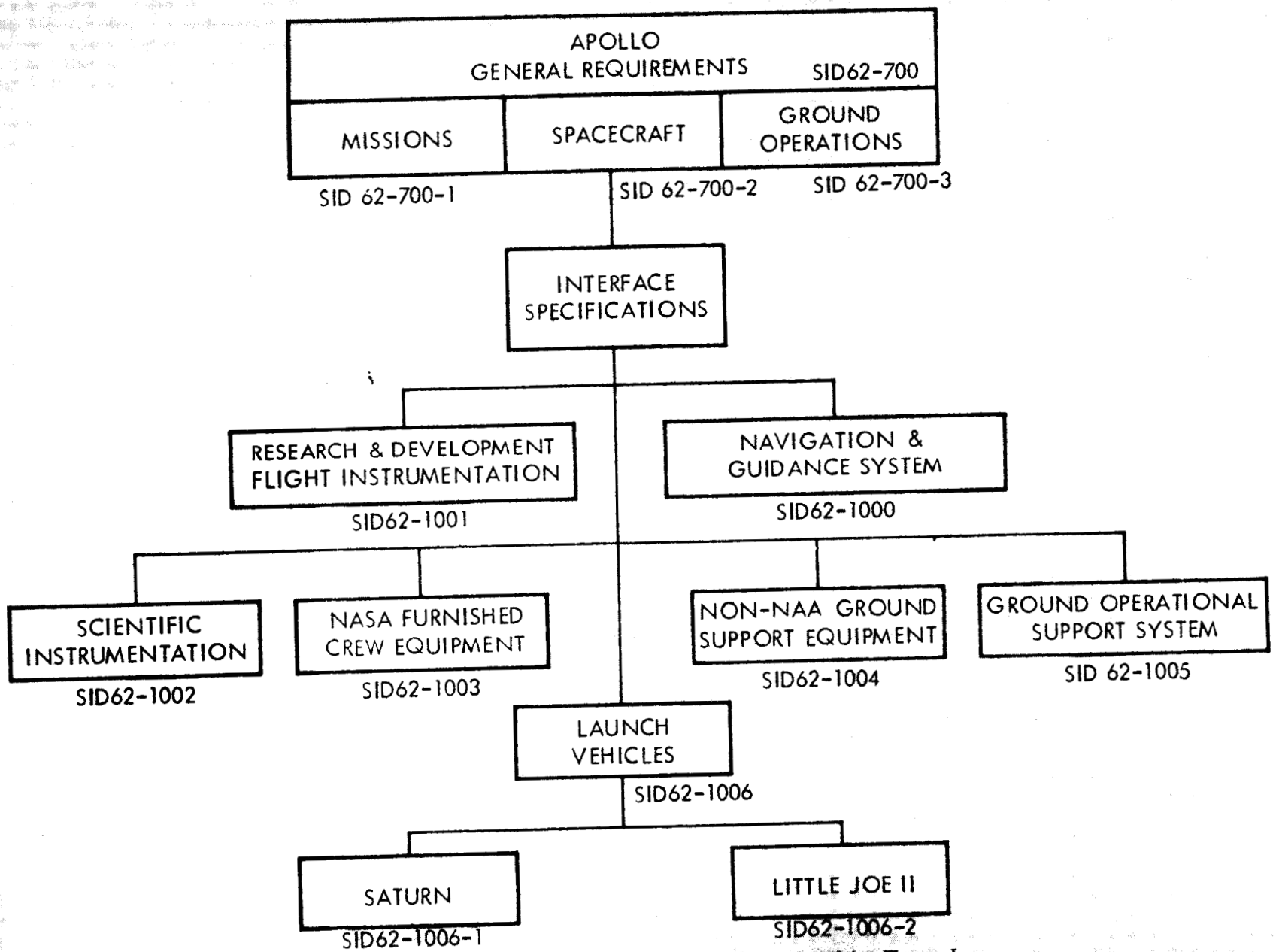
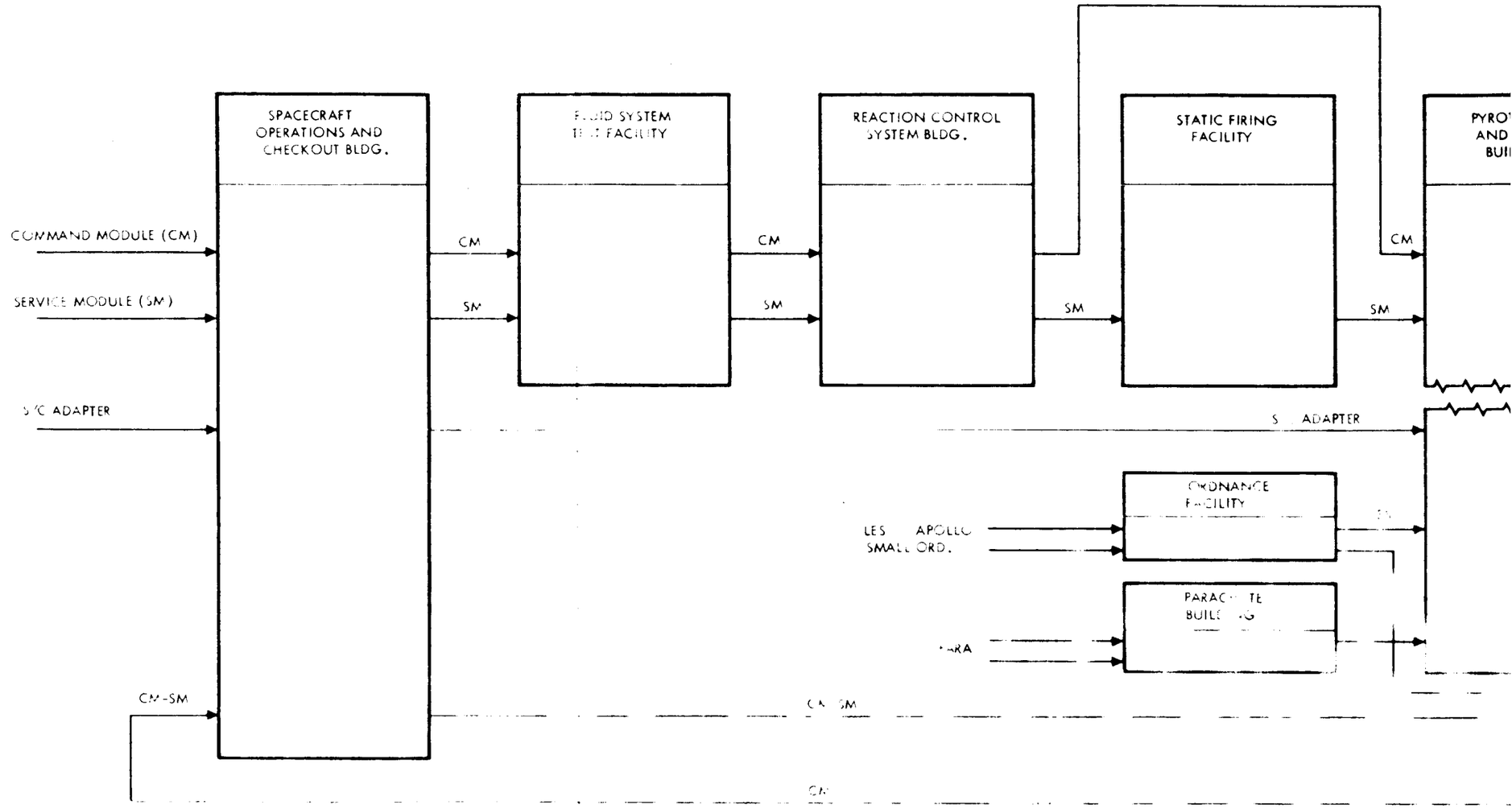
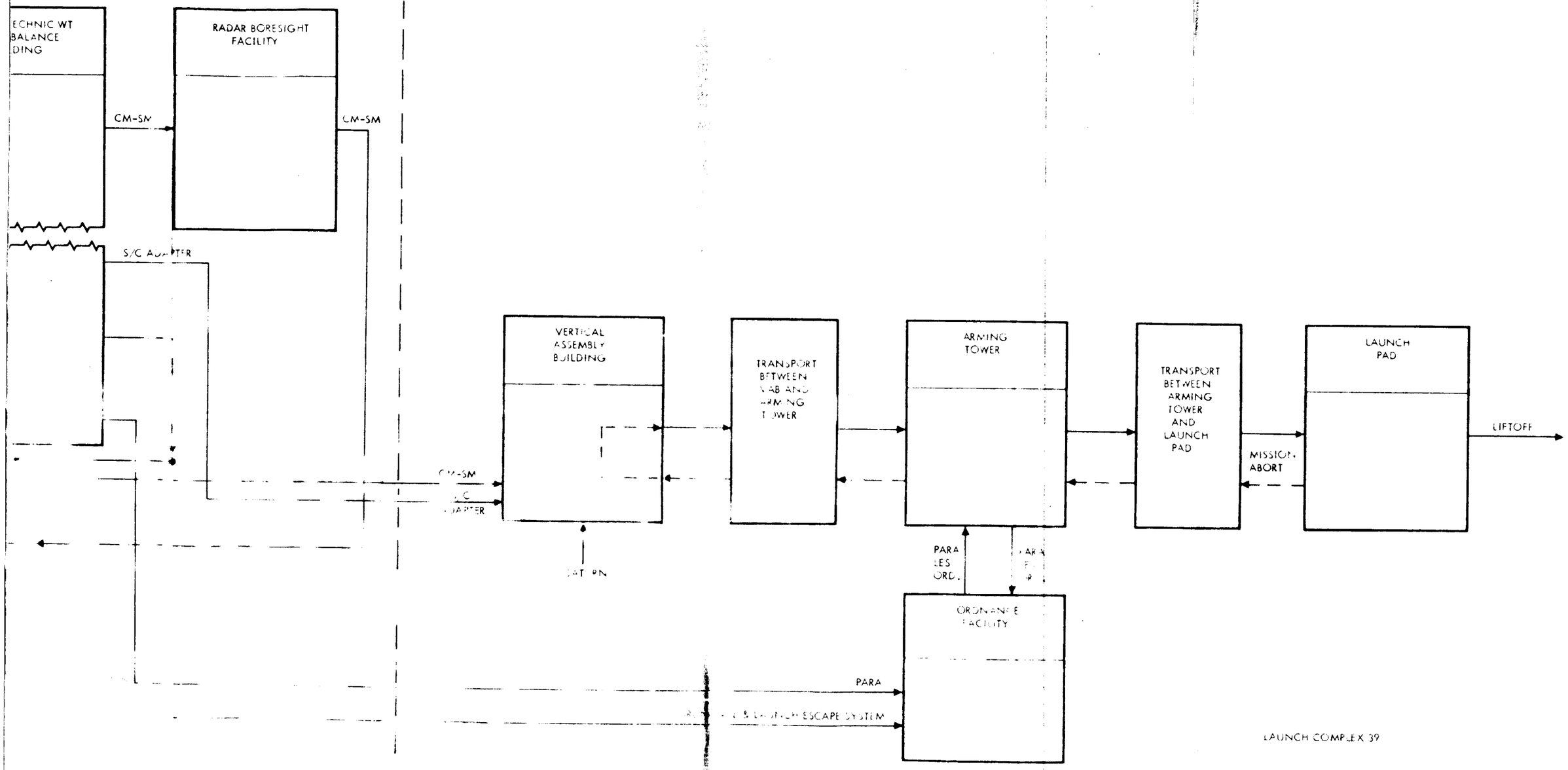


Figure 1. Apollo Specification Relationship Type I



MSC MERRITT ISLAND FACILITY

Foldout -1


ECHNIC WT
BALANCE
DING
CM-SM
RADAR BORESIGHT
FACILITY
CM-SM
S/C ADAPTER
VERTICAL
ASSEMBLY
BUILDING
TRANSPORT
BETWEEN
AB AND
RMING
OWER
ARMING
TOWER
TRANSPORT
BETWEEN
ARMING
TOWER
AND
LAUNCH
PAD
LAUNCH
PAD
LIFTOFF
MISSION
ABORT
CM-SM
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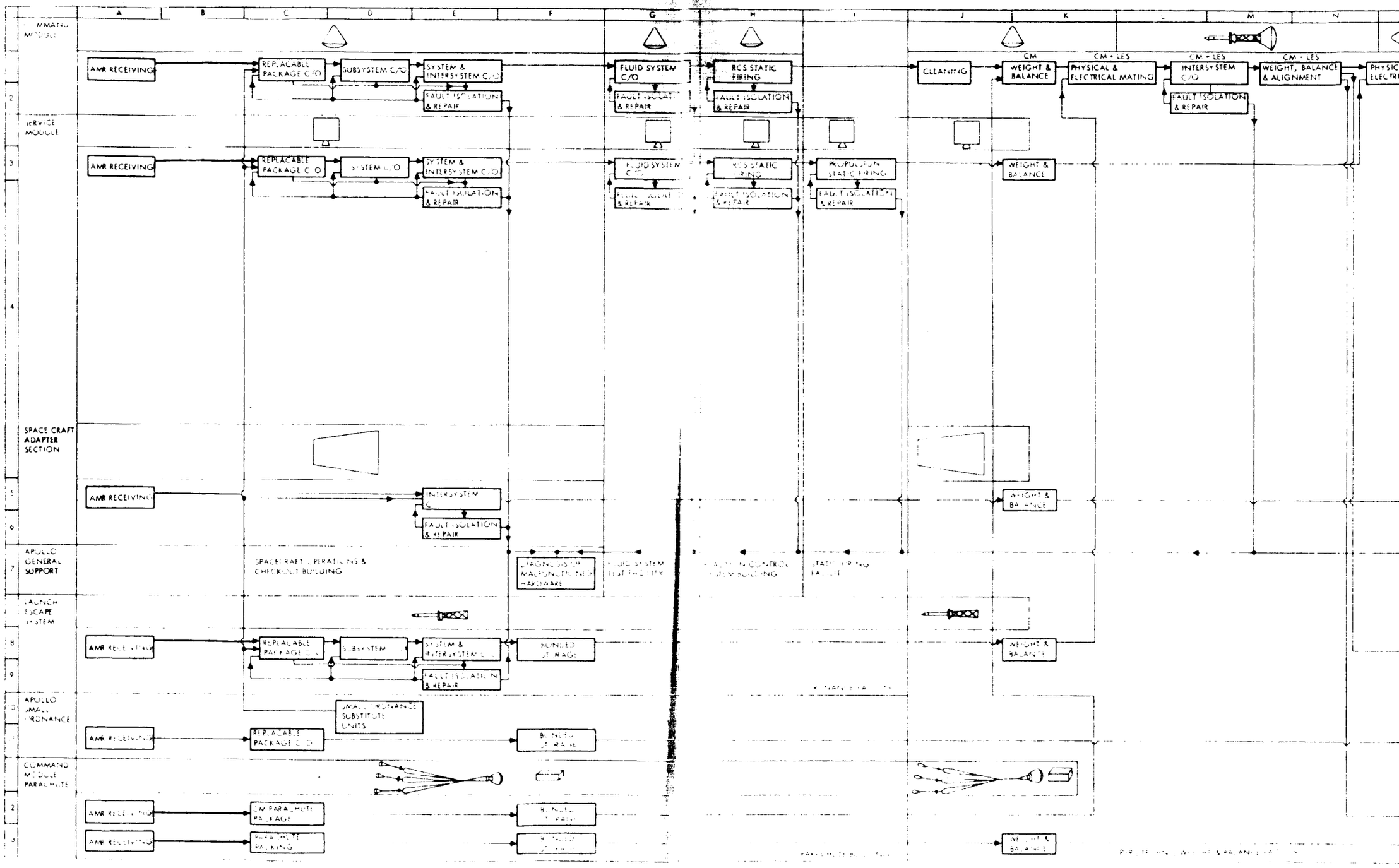
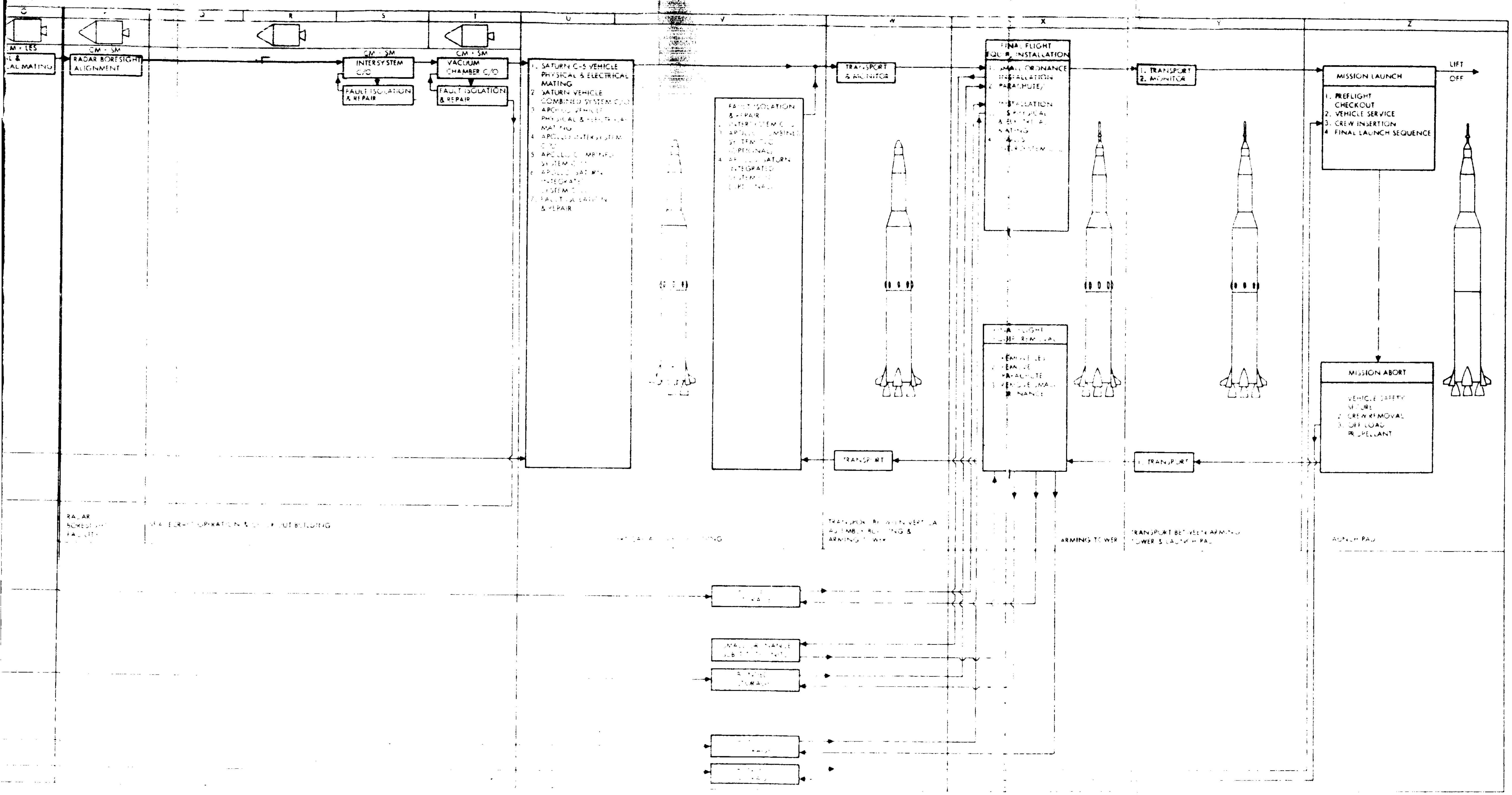
ORDNANCE
FACILITY
PARA
ESCAPE SYSTEM
LAUNCH COMPLEX 39

Foldout — 2

CONFIDENTIAL



Foldout 1



Foldout — 2

CONFIDENTIAL

CONFIDENTIAL

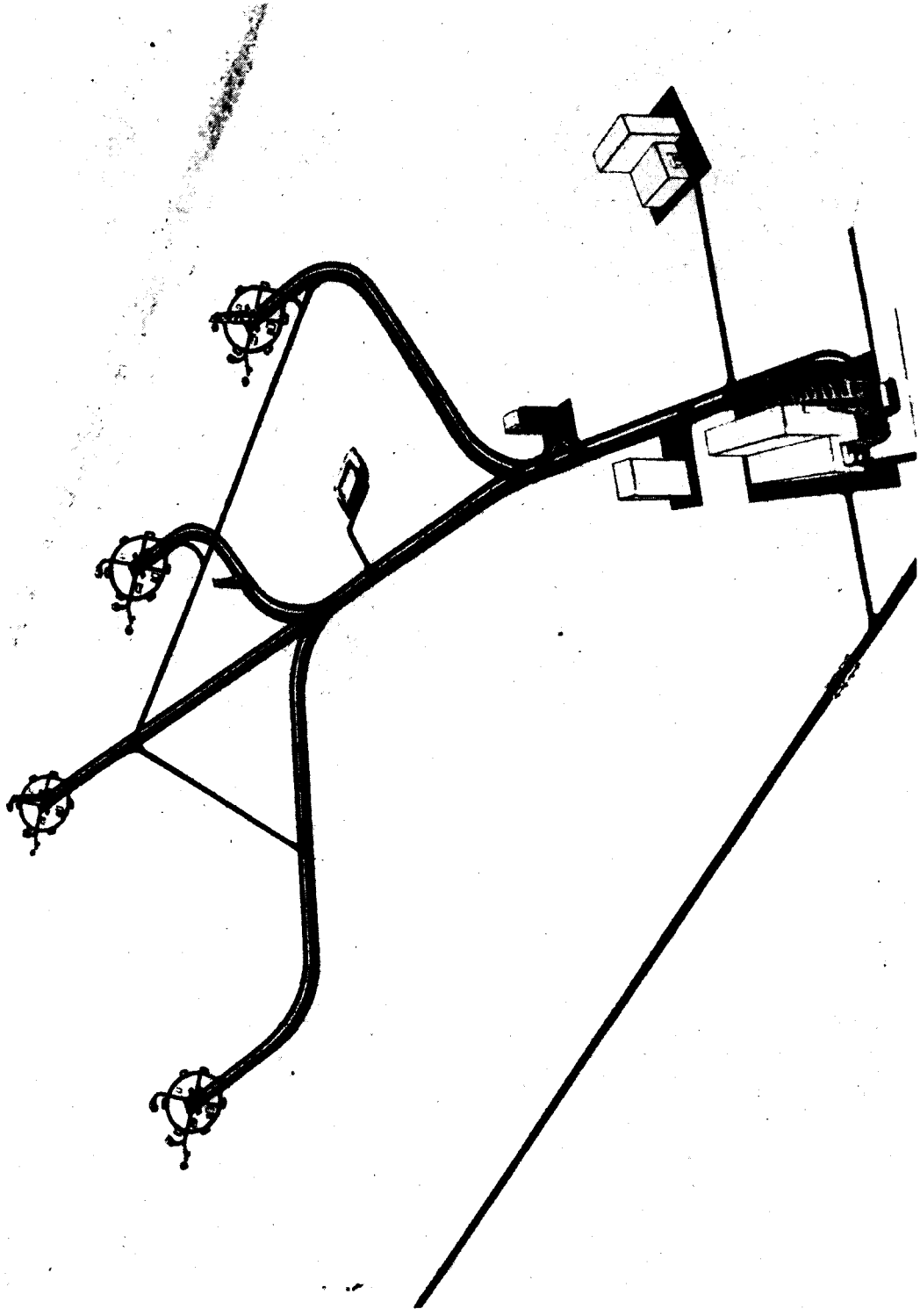


Figure 4 AMR Apollo Launch Complex

CONFIDENTIAL

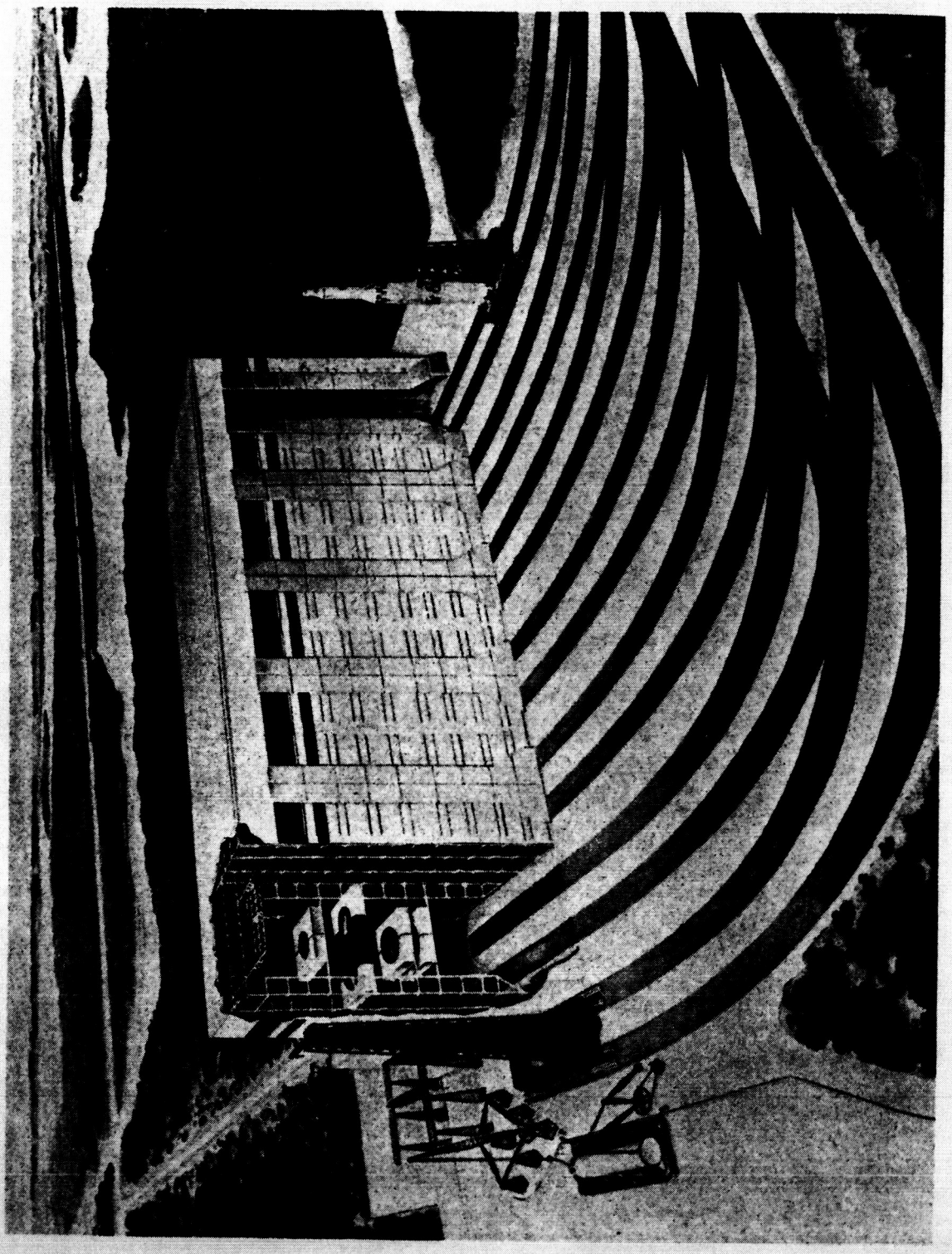


FIGURE 5 Vertical Assembly Building

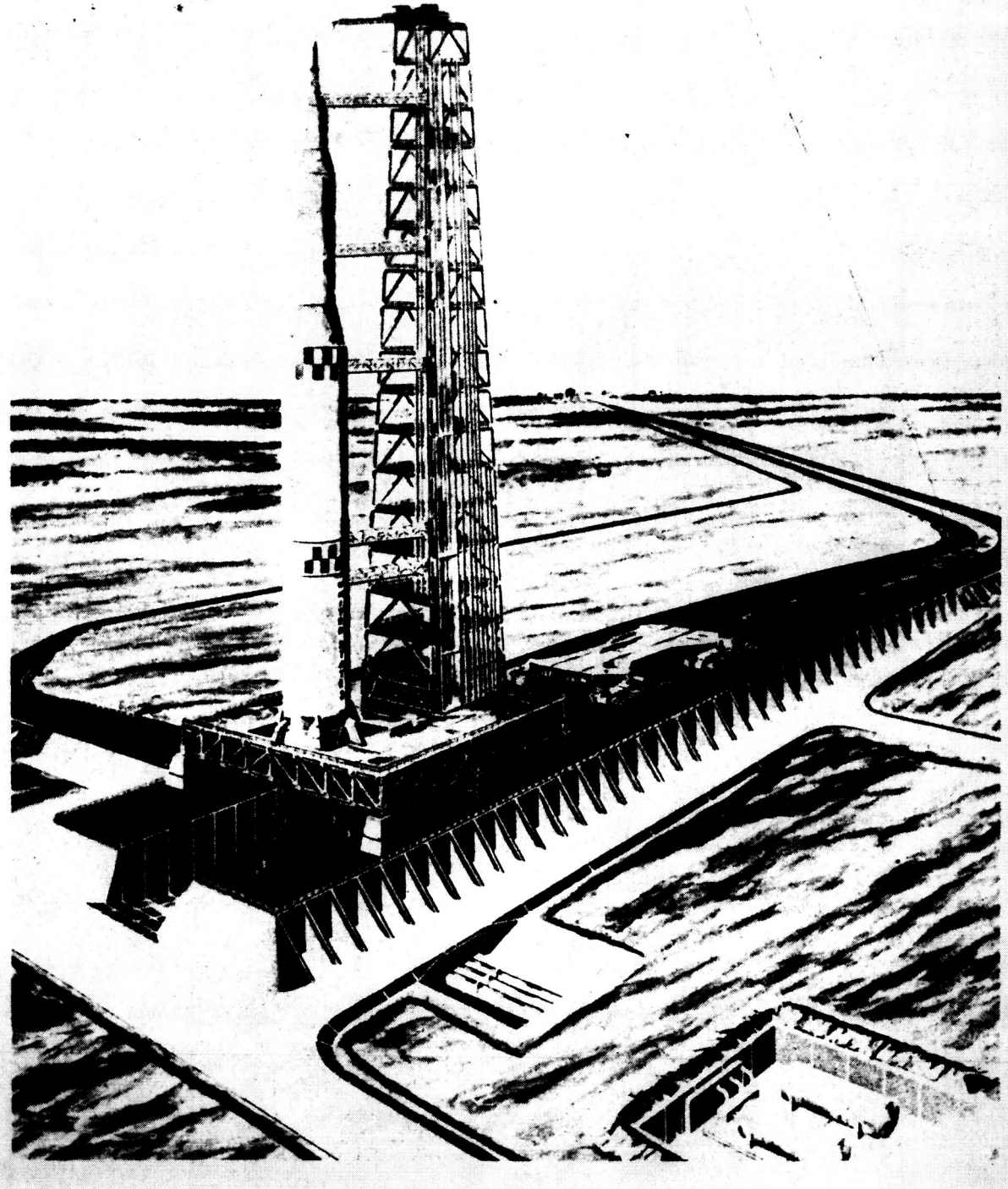


Figure 6. Launch Pad Area